

**What Is Claimed Is:**

1           1. A network address forwarding table lookup apparatus for  
2     identifying a fixed-length network address to determine a next  
3     hop address to which data packets having the network address  
4     should be forwarded, the apparatus comprising:  
5           a memory storing a compression-trie forwarding table, the  
6     forwarding table having a first level module, a second level  
7     module, and a third level module;  
8           the first level module comprising a first compression  
9     bitmap having first level index entries directly addressable by  
10    a first field of address bits from the network address of the  
11    data packets, and a first level pointer to the second level  
12    module, wherein each of the first level index entries  
13    alternatively comprises an independent index or a dependent  
14    index;  
15          the second level module comprising second level primary  
16    entries directly addressable by the first level pointer and the  
17    first level index entries comprising the independent index, each  
18    of the second level primary entries alternatively comprising a  
19    next hop index indicating the next hop address for the data  
20    packets while the first field of address bits is sufficient to  
21    determine the next hop index, or a second level submodule while  
22    the first field of address bits is not sufficient to determine  
23    the next hop address, wherein the second level submodule  
24    comprises a second compression bitmap having second level index  
25    entries associatively addressable by a second field of address  
26    bits from the network address of the data packets, and a second  
27    level pointer to the third level module, wherein each of the

28 second level index entries alternatively comprises the  
29 independent index or the dependent index; and

30 the third level module comprising third level primary  
31 entries directly addressable by the second level pointer and the  
32 second level index entries comprising the independent index,  
33 each of the third level primary entries comprising a next hop  
34 index indicating the next hop address for the data packets while  
35 the first and second fields of address bits are sufficient to  
36 determine the next hop index;

37 wherein each of the first level index entries comprising  
38 the independent index directly corresponds to one of the second  
39 level primary entry, each of the first level index entries  
40 comprising the dependent index associatively corresponds to the  
41 second level primary entry to which the previous first level  
42 index entry comprising the independent index directly  
43 corresponds, each of the second level index entries comprising  
44 the independent index directly corresponds to one of the third  
45 level primary entry, and each of the second level index entries  
46 comprising the dependent index associatively corresponds to the  
47 third level primary entry to which the previous second level  
48 index entry comprising the independent index directly  
49 corresponds.

1 2. The network address forwarding table lookup apparatus  
2 according to claim 1, wherein:

3 the forwarding table further has a fourth level module;  
4 each of the third level primary entries alternatively  
5 comprises a third level submodule while the first and second  
6 fields of address bits are not sufficient to determine the next  
7 hop address, wherein the third level submodule comprises a third

8 compression bitmap having third level index entries  
9 associatively addressable by a third field of address bits from  
10 the network address of the data packets, and a third level  
11 pointer to the fourth level module, wherein each of the third  
12 level index entries alternatively comprises the independent  
13 index or the dependent index;

14 the fourth level module comprises fourth level primary  
15 entries directly addressable by the third level pointer and the  
16 third level index entries comprising the independent index, each  
17 of the fourth level primary entries comprising a next hop index  
18 indicating the next hop address for the data packets while the  
19 first, second and third fields of address bits are sufficient  
20 to determine the next hop index; and

21 each of the third level index entries comprising the  
22 independent index directly corresponds to one of the fourth  
23 level primary entry, and each of the third level index entries  
24 comprising the dependent index associatively corresponds to the  
25 fourth level primary entry to which the previous third level  
26 index entry comprising the independent index directly  
27 corresponds.

1 3. The network address forwarding table lookup apparatus  
2 according to claim 2, wherein:

3 the forwarding table further has a fifth level module;  
4 each of the fourth level primary entries alternatively  
5 comprises a fourth level submodule while the first, second and  
6 third fields of address bits are not sufficient to determine the  
7 next hop address, wherein the fourth level submodule comprises  
8 a fourth compression bitmap having fourth level index entries  
9 associatively addressable by a fourth field of address bits from

10 the network address of the data packets, and a fourth level  
11 pointer to the fifth level module, wherein each of the fourth  
12 level index entries alternatively comprises the independent  
13 index or the dependent index;

14 the fifth level module comprises fifth level primary  
15 entries directly addressable by the fourth level pointer and the  
16 fourth level index entries comprising the independent index,  
17 each of the fifth level primary entries comprising a next hop  
18 index indicating the next hop address for the data packets while  
19 the first, second, third and fourth fields of address bits are  
20 sufficient to determine the next hop index; and

21 each of the fourth level index entries comprising the  
22 independent index directly corresponds to one of the fifth level  
23 primary entry, and each of the fourth level index entries  
24 comprising the dependent index associatively corresponds to the  
25 fifth level primary entry to which the previous fourth level  
26 index entry comprising the independent index directly  
27 corresponds.

1 4. The network address forwarding table lookup apparatus  
2 according to claim 3, wherein the network address is an Internet  
3 Protocol (IP) address.

1 5. The network address forwarding table lookup apparatus  
2 according to claim 1, wherein the independent index is a bit '1',  
3 and the dependent index is a bit '0'.

1 6. An IPv4 address forwarding table lookup apparatus for  
2 identifying a 32-bit Internet Protocol (IP) address to determine

3 a next hop address to which data packets having the IP address  
4 should be forwarded, the apparatus comprising:

5 a memory storing a five-level compression-trie forwarding  
6 table, the forwarding table having a first level module, a second  
7 level module, a third level module, a fourth level module, and  
8 a fifth level module;

9 the first level module comprising a first compression  
10 bitmap having two first level index entries directly addressable  
11 by the 17<sup>th</sup> address bit from the IP address of the data packets,  
12 and a first level pointer to the second level module, wherein  
13 each of the first level index entries alternatively comprises  
14 a bit '1' or a bit '0';

15 the second level module comprising second level primary  
16 entries directly addressable by the first level pointer and the  
17 first level index entries comprising the bit '1', each of the  
18 second level primary entries alternatively comprising a next hop  
19 index indicating the next hop address for the data packets while  
20 the first to the 17<sup>th</sup> address bits of the IP address sufficient  
21 to determine the next hop index, or a second level submodule  
22 while the first to the 17<sup>th</sup> address bits of the IP address are  
23 not sufficient to determine the next hop address, wherein the  
24 second level submodule comprises a second compression bitmap  
25 having 128 second level index entries associatively addressable  
26 by the 18<sup>th</sup> to the 24<sup>th</sup> address bits from the IP address of the  
27 data packets, and a second level pointer to the third level  
28 module, wherein each of the second level index entries  
29 alternatively comprises the bit '1' or the bit '0';

30 the third level module comprising third level primary  
31 entries directly addressable by the second level pointer and the  
32 second level index entries comprising the bit '1', each of the

33 third level primary entries alternatively comprising a next hop  
34 index indicating the next hop address for the data packets while  
35 the first to the 24<sup>th</sup> address bits of the IP address are  
36 sufficient to determine the next hop index, or a third level  
37 submodule while the first to the 24<sup>th</sup> address bits of the IP  
38 address are not sufficient to determine the next hop address,  
39 wherein the third level submodule comprises a third compression  
40 bitmap having two third level index entries associatively  
41 addressable by the 25<sup>th</sup> address bit from the IP address of the  
42 data packets, and a third level pointer to the fourth level  
43 module, wherein each of the third level index entries  
44 alternatively comprises the bit '1' or the bit '0';

45 the fourth level module comprising fourth level primary  
46 entries directly addressable by the third level pointer and the  
47 third level index entries comprising the bit '1', each of the  
48 fourth level primary entries alternatively comprising a next hop  
49 index indicating the next hop address for the data packets while  
50 the first to the 25<sup>th</sup> address bits of the IP address are  
51 sufficient to determine the next hop index, or a fourth level  
52 submodule while the first to the 25<sup>th</sup> address bits of the IP  
53 address are not sufficient to determine the next hop address,  
54 wherein the fourth level submodule comprises a fourth  
55 compression bitmap having 128 fourth level index entries  
56 associatively addressable by the 26<sup>th</sup> to the 32<sup>nd</sup> address bits  
57 from the IP address of the data packets, and a fourth level  
58 pointer to the fifth level module, wherein each of the fourth  
59 level index entries alternatively comprises the bit '1' or the  
60 bit '0'; and

61 the fifth level module comprising fifth level primary  
62 entries directly addressable by the fourth level pointer and the

63 fourth level index entries comprising the bit '1', each of the  
64 fifth level primary entries comprising a next hop index  
65 indicating the next hop address for the data packets;

66 wherein each of the first, second, third and fourth level  
67 index entries comprising the bit '1' directly corresponds to one  
68 of the next level primary entry in sequence, and each of the  
69 first, second, third and fourth level index entries comprising  
70 the bit '0' associatively corresponds to the next level primary  
71 entry to which the previous same level index entry comprising  
72 the bit '1' directly corresponds.

1 7. A network address forwarding table lookup method for  
2 identifying a network address with a compression-trie  
3 forwarding table to determine a next hop address to which data  
4 packets having the network address should be forwarded, the  
5 compression-trie forwarding table having multiple level  
6 entries, the method comprising the steps of:

7 retrieving a first field of address bits of the network  
8 address, and searching for a bit in the first level entries of  
9 the compression-trie forwarding table, wherein the bit directly  
10 corresponds to the first field;

11 searching for an indicative entry in the next level entries  
12 of the compression-trie forwarding table, wherein the  
13 indicative entry associatively corresponds to the bit;

14 obtaining a next hop index indicating the next hop address  
15 while the indicative entry comprises the next hop index; and

16 retrieving a next field of address bits of the network  
17 address, and searching for a next bit in the indicative entry  
18 while the indicative entry does not comprise the next hop index,

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19 wherein the next bit associatively corresponds to the next  
20 field.

1 8. The method as claimed in claim 7, wherein the network  
2 address is an Internet Protocol (IP) address.